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Studying Performance and Combustion Characteristics of Biodiesel from Walnut Oil by Using RK Diesel Analysis

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ABSTRACT
There is a strong global interest in producing alternative and renewable engine fuels due to factors including declining oil supplies, rising oil costs, exhaust emissions' damage to the environment, and global warming. The application of biodiesel as a substitute fuel is taken very seriously. The goal of the study is to find the ideal compression ratio for biodiesel made from used cooking oil in various amounts. The process is greatly impacted by the compression ratio, which also offers an exceptional level of motor performance control. For traditional internal combustion engines, the compression ratio is fixed, leading to a compromise between the conflicting needs. A variable compression rate engine may be used to study the compression impact of various biodiesel mixes under various loads. The edible walnut is utilized in this effort to produce biodiesel. Numerous experts have experimented with different types of biodiesels in different diesel engines. The goal of the current study is to compare the performance, combustion, and emission characteristics of biodiesel mixes with those of standard diesel. Direct injection diesel engine combustion characteristics are simulated using the DIESEL-RK

1. Introduction

Energy is the primary driver of economic development in addition to social growth. Diesel engines in a number of countries are widely used as main movers in the fields of transport, agriculture and power generation. However, owing to the high expense and increasing depletion of fossil products, there is an intensive search for renewable fuels. Both developed and developing countries, it is important to raise the use of diesel fuel. In order to fulfil our basic requirements and ensure sustainable growth, an adequate amount of energy resources is required. In the future, economic forecasts rely mainly on the high level of energy convenience in increasing quantities from harmless, stable and biodegradable resources.

Energy has a need and a high appetite that is increasing dramatically, so the electricity supply need will be expanded by up to 36% in 2035 [1]. Owing to the rise in population, the demand for fuel is also growing and the growth of the population of developing countries such as China and India will be projected at up to 25% in the coming years. Higher energy consumption is also a crucial element of the production of the economy to boost the way of life, which growing puts strain on energy supplies. The best sample study as an illustration is that the energy supply demand in India can be projected to rise by 75% in 2035 [2].

Biodiesel – an alternative fuel

Biodiesel is the perfect replacement for fossil fuels. It can be prepared from vegetable oil and animal facts by means of an alcohol or transesterification process. Biodiesel may be used as such or combined with fossil fuels in various amounts. Transesterification is carried out to reduce crude viscosity. Plant's oil such as jatropha, pongamia, rice bran, neem, karanja, soybean, cotton seed has been used as biodiesel and is reportedly under investigation.

Biodiesel is primarily produced from plants in India. Throughout India, the following biodiesels are widely used [5].

Walnut - Walnut generally contains about 60% oil, but varies from 52% to 70% depending on the variety. The most abundant one is an omega-6 fatty acid called linoleic acid.

Jatropha- The oil content of jatropha seeds is 37% that burns a clear smoke free flame. The Byproducts can be used as organic fertilizer and insecticide. The fatty acid composition of Jatropha oil**.**

Mahua- The oil content of mahua is 30-40%. The byproducts are used as fodder and fertilizer. The fatty acid composition of Mahua oil is Palmitic.

Karanja- Shows that the oil content of Karanja is 27.5%. The fatty acid composition of Karanja oil is Palmitic.

Neem- Shows that The fat content of neem is 33-45%. The fatty acid composition of Neem oil is Linoleic acid.

2. Methodology

A vegetable or animal fat is chemically reacted with an alcohol, such as methanol or ethanol, to create biodiesel, an alternative fuel for diesel engines. The reaction may be expressed as follows: Oil + alcohol → biodiesel + glycerin Compared to other vegetable oils, walnut oil has the highest proportions of polyunsaturated fatty acids (up to 78% of the total fatty acid content). Linoleic acid (49–63%), oleic acid (13.8–26.1%), palmitic acid (6.7–8.7%), stearic acid, and linoleic acid (8–15.5%) are among the fatty acids found in walnut oil.

Acid (1.4 to 2.5 per cent).Walnut oil can become rancid like any other nut, seed or vegetable oils.

Jammu and Kashmir is the largest walnut growing state with a output of about 2.66 lakh metric tons on 89,000 hectares of land and contributes to more than 98% of the overall walnut production in India.Our state contributes about 98% of the country's walnut exports.

Table 1. Properties of bio diesel blends

Property	Diesel	10% MEWO	20% MEWO	MEWO
C%	88	84	83	77
H%	13	12	13	12
O%	0.004	0.0145	0.025	0.109
Density at 15°C	830	835	839	870
Viscosity at 40 °C	3.0	3.19	3.4	4.9
Calorific value	42.5	42.27	42.04	40.20
Flash point (°C)	76	81.4	87	130
Cetane number	48	48.3	48.6	51
Molecular weight	190	200.6	211.2	296

3. Production of WME (Walnut oil methyl esters)

Walnut oil has been chosen for biodiesel production in this report. Below is the method for biodiesel production: The following:

3.1 Transesterification

"Transesterification" requires a chemical process that converts palm oil or animal fat into biodiesel. This is a long name for the basic process of combining an oestrogen derivative with alcohol for the production of an ester and another product. Oil and fat are part of the ester family. Methyl or ethyl ester and a new glycerol alcohol, or more commonly glycerin, are produced when they react with methanol or ethanol.

Triglycerides are vegetable oils and animal fats. Three fatty acids and glycerol are triacyl glyceride esters (TAGs). Glycerol is a 3-hydrophilic hydroxylic polyhydroalcohol ethyl. Fatty acids are long-chained carboxylic acids. There is a average of 10 to 30 carbons in the hydrocarbon chain. Three R'COOH, R'-COOH and R 'COOH acids are chemically linked to glicerol in the form of TAGs.

Under some circumstances, fatty acids in glycerides can disassociate into Free Fatty Acids (FFAs). t. The figure shows the transesterification response to methanol in the form of fatty acid esters (FAMEs) as a commonly recognized triglyceride. Chemical treatment of triglycerides or complex fats, neutralization of free fatty acids, extraction of glycerol and processing of alcohol esters are all part of a transesterification. Glycerol’s and catalysts are placed above the mixing tank after the reaction. Glycerol and catalyst are extracted after a while and fames remain in the tank. The FAMEs will in the majority of cases be washed with water to remove any traces of the drug's residual alcohol, catalyst and glycerol.

3.2 Steps for Simulation methodology

Diesel-RK is a specially built program for modeling and simulation of the for thermodynamic simulation engine. It is explicitly designed to model and automate internal processes with stimulus of all kinds. The program optimizes fuel injection profiles, including multi-injection curves, sprayer configuration and location as well as fuel consumption estimates, fuel injector profile emission analysis as well as the piston bowl shape in DI Diesel modeling

Step-1 First of all, launch the Programme and then announce the engine specifications: engine type (diesel or petrol), size of cylinder configuration and form of cooling, key engine parameters, piston stroke (S), boron (D), ratio of compression, engine speed, ambient parameters (temperature and pressure), turbo charge and intermediate cooling.

4. Results and Discussion

The results of combustion, efficiency and emission characterization of a 4,4 kW single cylinders, four-stroke air-cooled DI diesel engine the results of the fuel-powered engine with specific biodiesels combustion, efficiency and emission parameters are compiled here on a motor simultaneous method (Diesel RK).

4.1 Performance Parameters

The performance parameters like, specific fuel consumption, engine torque, volumetric efficiency, mechanical efficiency and brake thermal efficiency are observed for the biodiesel blends. The results obtained were discussed below:

- **Brake Thermal Efficiency**

The brake's thermal efficiency demonstrates how well an engine converts chemical energy into mechanical energy. Figure 1 demonstrates differences in the thermal performance of brake biodiesel for charging mixtures. BTE 's motor costs are up to 80% and decrease at a maximum charge due to incomplete combustion.

BTE decrease can be induced by increased fuel and viscosity levels in biodiesel fusion. Therefore, the engine is using more fuel to compensate for the lower heating gain with the same braking force. Full load BTE is 30% for B10, B20, B30, B75 and B100, 29.81%, 27.11%, 25.53% respectively. The full load of this fuel is 30.0%. 30,0 percent of BTE.

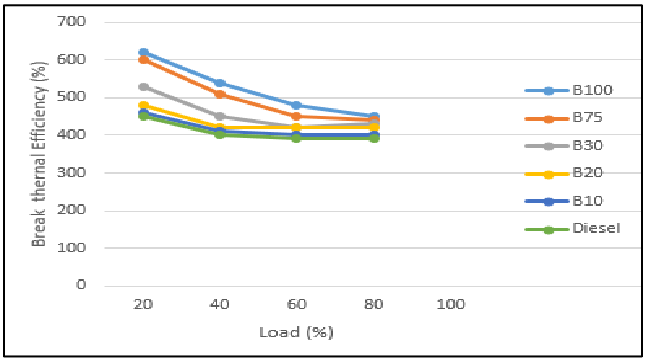

Fig. 1 Brake thermal efficiencies of different blends at different loads

- **Specific fuel consumption**

Specific fuel consumption is the mass of fuel consumption in kg by an engine per unit of work done by the engine

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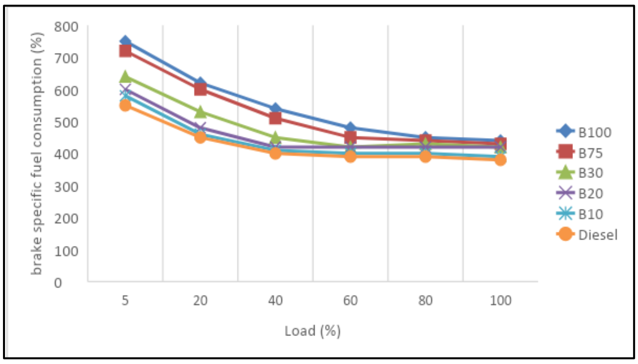

Fig. 2 Brake specific fuel consumption of different blends at different loads

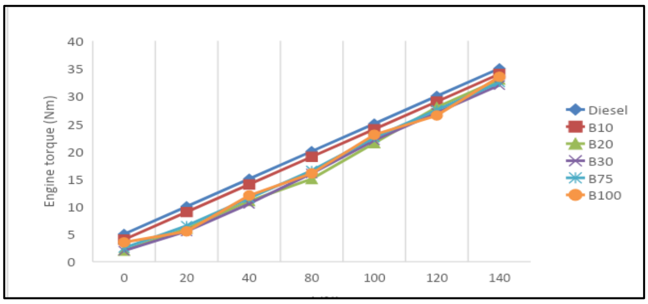

Fig. 3 Difference in the usage of diesel fuel and walnut biodiesel blends for brake specific fuel

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- **Engine torque**

Torque is a working variable. Figure 3 shows the torque variability of the diesel engine and its biodiesel mixtures with load shift. For the B10, B20, B30, B75 and B100, the meantime torque was 28.42Nm, 28.73Nm and the average torque was 28.25Nm and 27.44Nm and this for the B10, B20 was 27.19Nm. With increased load for all blends, the torque of the motor increases. In contrast to diesel and other bio-diesel blends, samples B10 and B20 indicate higher engine torque. At full load B20 is 28.73 Nm with the maximum torque of generator, 27.19 Nm with diesel engine. The torque was maximum for the lower biodiesel blends was due to proper combustion of the fuel.

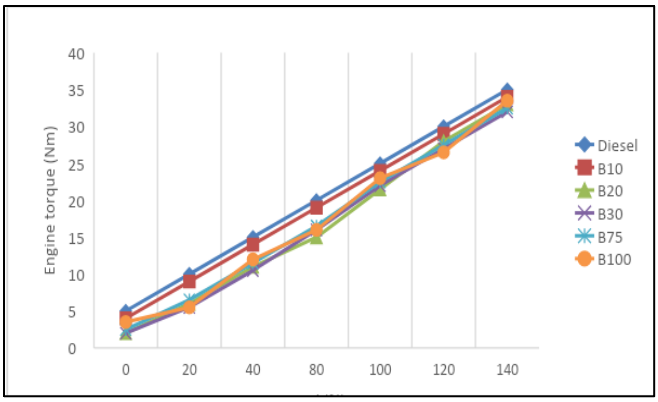

Fig 4. Variation of engine torque with load

- **Volumetric efficiency**

Volumetric efficiency is the ratio of the air-carburant mixture's mass density drawn into the cylinder to the mass density of the same air volume in the container. The volumetric output variance for the entire mix with load variability is shown on Figure 4. With an increase in load, volumetric efficiency decreases. The maximum was not loaded and the charge decreased linearly.

Compared to diesel, the biodiesel combinations showed improved volumetric efficiency. For B12, B20, B75, B100 and B100 mixtures, the volumetric efficiency observed for full load was 80.80%, 81.55%, 81.33% and 81.18%, which was 80.24% for diesel. At full load of 15kg, B20 recorded maximum volume output, whereas for the B10 mixing, it was at no load and decreases slowly as load increases. In comparison with other biological blends, diesel has recorded the lowest volumetric efficiency. Biodiesel is higher than normal diesel because of its higher density.

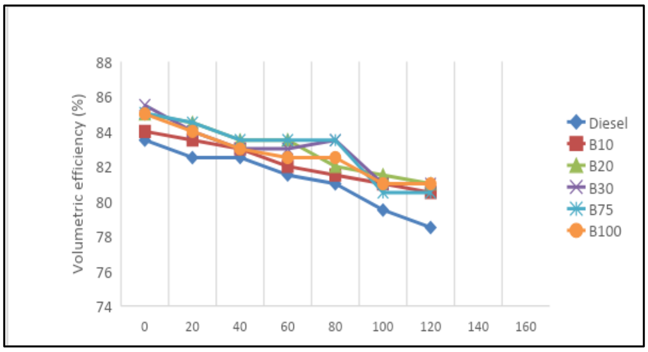

Fig 5. Variation of volumetric efficiency with load

The following conclusion was made after the Simulation:

- BTE increases for all fuels with an increased load. Of four biodiesel mixtures, the B30 mix records the maximum BTE, but 7.02% lower than Petrol.
- The volumetric efficiency observed is higher for the B10 as compared to diesel by 1.31%.
- The indicated thermal efficiency observed is slightly higher for the diesel as compared to B10. The indicated thermal efficiency values for the mineral diesel and B10 are 48.15% and 45.07% correspondingly at peak load.

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